DOCUMENT RESUME

ED 217 885 IR 010 271

AUTHOR Buterbaugh, James G.
TITLE Alternative Media Storage/Retrieval Systems--A Futuristic Forecast for Educational Technologists.
INSTITUTION Information Futures, Pullman, Wash.
REPORT NO ISBN-0-931450-17-9
PUB DATE Nov 80
NOTE 36p.
AVAILABLE FROM Information Futures, 2217 College Station, Pullman, WA 99163-0904.

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Computer Science; Delphi Technique; *Educational Media; *Educational Technology; Futures (of Society); *Information Retrieval; *Information Storage; Merchandise Information; Microcomputers; Online Systems; Prediction; *Technological Advancement; *Videodisc Recordings
IDENTIFIERS Intelligent Video; National Institute of Education

ABSTRACT

Included in this thorough overview of the probable future developments in videodisc technology and its role as an educational medium are (1) a review of current educational technology literature on videodiscs, which summarizes a U.S. Navy Delphi Study of videodisc technology use through 1986, discusses a National Institute of Education (NIE) study on learning and teaching, and outlines various other studies on microcomputers and videodiscs and their likely impacts on educational practices; (2) descriptions of the characteristics and capabilities of the major contemporary videodisc systems, in particular the Matushita JVC Videodisc System, the RCA SelectaVision System, the MCA-Philips-Magnavision System, and the MCA-Pioneer DiscoVision Industrial/Educational Player; and (3) technical accounts of such future technological prospects as the emergence of videodisc erase and re-record capability and the rapid increase of microcomputer information storage and retrieval capability. A 23-item reference list, a 108-item educational technology bibliography, and a 58-item engineering technology bibliography accompany the text. (JL)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

ED217885

# ALTERNATIVE MEDIA STORAGE/RETRIEVAL SYSTEMS—A FUTURISTICS FORECAST FOR EDUCATIONAL TECHNOLOGISTS

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

by

**James G. Buterbaugh, Professor**
**Department of Educational Systems and Learning Resources**
**University of Utah**

**INFORMATION FUTURES**
**2217 College Station**
**Pullman, Washington 99163**

**November 1980**

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

G.R. Brong

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."



IR010271

© James Buterbaugh, Salt Lake City

ISBN 0-931450-17-9

INFORMATION FUTURES
2217 College Station
Pullman, WA 99163

*Alternative Media Storage/Retrieval Systems—A Futuristics Forecast for Educational Technologists* by James Buterbaugh has been written and distributed to stimulate planning, thought and discussion among educational technologists. Reactions from users of this issue paper are solicited, observations are welcome, and further forecasts encouraged.

## PREFACE
## COUNTDOWN-TO-DAWN

Technology is barely 4,000 years old—a science and technology of instruction had beginnings in the early twentieth century—some time less than eighty years ago. If, indeed, we could compress these years and experience them in just twenty-four hours, we would, at the end of the period, find ourselves standing at the dawn of a new day—contemplating what educational technologists have experienced and facing the future of learning improvement with new wonder.

We would remember that yesterday began quietly, its sunrise marked by Thorndike's Theory of Connectionism and Technology of Instruction. The first available educational films were initially theatrical productions. One of the first film catalogs (1910) prefaced its meager listings with this statement:

> The word "educational" is here used in a wide sense and does not indicate that these films are intended for school or college use exclusively. They are intended rather for the education of the adults as well as the youth, for the exhibition before miscellaneous audiences, as well as for more restricted use.

When principally designated bureaus or departments of visual instruction acquired and disseminated an extensive range of educational media, the "**audio visual**" instructional movement began. Barely three hours ago, we were presented with the Victor Cine Projector, the Eastman Kodascope Model C, **Chronicles of American Photoplays** and "**audio-visual**" sound film from Electrical Research Products, Inc. (better known as ERPI and pronounced as "urpi"). Less than two hours ago, World War II brought the first significant convergence of the "**audiovisual**" tributary within the mainstream of **instructional technology.**

Only slightly more than an hour ago, the National Defense Education Act (NDEA) spurred research and experimentation in the more effective utlization of television, radio, motion pictures and related media for instructional purposes. Within the past one-half hour, we observed an increasing concern for improving storage and dissemination of instructional technology research through the establishment of the Educational Research Information Center (ERIC). The Educational Film Library Association (EFLA) and the Educational Products Information Exchange (EPIE) were separately organized to evaluate, codify and disseminate reliable instructional system and learning resource data. Within the past twenty minutes, computer assisted instruction (CAI) and electronic video recordings (EVR) debuted. A vast array of microcomputers expanded our microuniverse only the past quarter hour. Twelve minutes ago, a laser beam impressed data onto a 30-cm videodisc which features long-life tellurium film. The eighth edition of the **Thesaurus of ERIC Descriptors** added the referent "**Videodisc** (one word) **Recordings**" and revised "**Video tape** (two words) **Recordings**" to "**Videotape** (one word) **Recordings.**" General revision of the Copyright Law became effective seven minutes ago with a bundle of rights and "Fair Use"; three minutes ago, U.S. District Court Judge Warren Ferguson ruled, in a landmark decision, that:

> . . . non-commercial home use video recording of material broadcast over the public airwaves **does not** constitute copyright infringement.

As the morning sky brightened, the closing moments before sunrise brought other miracles: imaginative educational applications for holography and other laser technology; magnetic bubble domain memory systems, satellite and optical fiber communications systems; scores of technical improvements contrived at ever-quickening speed and reduced cost; and instructional design procedures for improved competence development.

Now we scan the horizon in anticipation of what marvels this new day will bring . . . searching for a hint of the meaningful directions instructional television may take.

# ALTERNATIVE MEDIA STORAGE/RETRIEVAL SYSTEMS—A FUTURISTICS FORECAST FOR EDUCATIONAL TECHNOLOGISTS

By
Dr. James G. Buterbaugh

As implied in the Preface, "Countdown-to-Dawn," the need for a continuum of meaningful indicators for instructional technology progress has become increasingly apparent. Our assessment of the rapid instructional technology activities of the past eighty-some years, coupled with recent research efforts, may reveal trends which cast additional insight on the evolving avenues that the instructional technology genius will follow in this decade of the 1960s.

## A Review of Current Educational Technology Literature

Delphian oracles, employing divergent predictive techniques, have provided the futuristics foundation for this monograph. Ludwig Braun (1) has written about the difficulty to predict the character of the classroom a decade hence, or the role of the computer in supplement with complementary emerging video techniques. There are those visionaries who predict the character of the classroom a decade hence, or the role of the computer supplemented by complementary emerging video techniques. There are those visionaries who predict that classrooms will **disappear** within a decade, or two at the most, and that all learning will take place within the individual home setting and that the computer will play a central role. Braun agrees that this is a possible outcome, but that it isn't a likely one. In view of the dizzying pace of technological developments since 1975, many economical, political and sociological forces could emerge a new educational culture with changes as the rule rather than the exception.

## A Delphi Study

The U.S. Navy Personnel Research and Development Center (2) has released a useful educational technology projection document entitled **Videodisc Technology Use Through 1986: A Delphi Study**. The objective of this research was to forecast the potential impact of videodisc technology upon Navy training programs for a ten-year period by measuring and interpreting the opinions of a panel of experts. The DELPHI, a methodology for systematic solicitation and collection of informal judgments, was the primary research technique employed. Issues were identified by surveying eighty-one panelists in Round One with the intent of predicting changes by 1986 in technology, education, and instructional design as the result of videodisc/computer evolutions.

From these responses, 136 predictive statements were developed and classified into eleven prediction categories. In Round Two, the surveyed panelists were requested to rate the probability of each prediction statement occurring by 1986 and then to evaluate their own personal confidence in this futuristics probability rating process. Means, medians, standard deviations and interquartile ranges were computed.

In Round Three, prediction statements which raised high agreement among the panelists were grouped and other statements were then rewritten or added. Finally, in Round Four, panelists were requested to rank 151 prediction statements which represented a compilation of every initial prediction of the entire exercise. Statistically Z-scores were derived from the rating distributions, thus providing a method for ranking the prediction statements on a normal curve.

**Results of This Delphi Videodisc Technology Forecast**

1. **Cultural Impact**: No high consensus responses.
2. **Entertainment Aspects**: Film and broadcast producers will place greater restrictions on videodisc rights; there will be four-channel sound via videodisc; there will not be a reduction in paid attendance to "out-of-home" events; publishing houses will produce directly for videodisc.
3. **Mass Communications**: Videodisc periodicals will merge motion, still, print, and nonprint media; local broadcast stations will not be eliminated; videodiscs will assume an "economically self-generating" position by 1986.
4. **Technology**: Videodisc systems will incorporate random access with expedited bit memories, disc changers, CW and solid-state lasers, flat electronic display, and large-screen display.
5. **Commercial Applications**: Standardization will be achieved by market place elimination; motion picture reissues on disc will be less popular than videodisc periodicals; magnetic tape will be used where read/write capability is important; if two systems emerge, the less expensive medium will be used in homes and the more expensive, in institutions; the relative costs of all video record-playback machines (tape, cassette) will decrease.
6. **Quality of Education**: The gulf between highly educated and under-educated societies will not have widened; videodiscs will allow an increase in learning if educators are willing to use them for that purpose; educational uses of videodiscs will lag behind their availability.
7. **Institutional Education**: Videodiscs will facilitate the growth of open learning, individualized instruction, and audiovisuals used in nonlinear instructional design.
8. **Noninstitutional Education**: The physically limited will have more access to education; continuing professional education will be presented on discs; off-campus secondary education will be seen.
9. **Educational Feasibility**: Nonentertainment users will be more inclined to purchase videodisc hardware and software if the cost remains less than comparable videotape hardware and software.
10. **Educational Media**: Freeze frame, frame address, and fast random access will be necessary and sufficient for interactive branching systems; overall use of audiovisual formats will increase, videodiscs will engender more use of audiovisuals to supplement texts.
11. **Library Applications**: No high consensus responses.

**Conclusions:**

The Navy can expect videodisc systems—in both optical and capacitance formats—to be available for use in Navy training by 1986. An increasing use of multi-media formats is also expected.

**Recommendations:**

1. The Navy should assist in the development of optical videodisc systems since such systems are more suited to Navy training requirements.
2. The Navy should increase research and development investments in multi-media instruction.
3. Investigations should be initiated to determine the relative instructional effectiveness of various media and to develop a methodology that accounts for individual differences and establishes optimal media combinations.
4. A systems approach should be developed that addresses the procedures, facilities, and costs of videodisc delivery systems, as well as the use of videodiscs for delivery and selection of appropriate intermediary instructional development media.
5. Research and development should be conducted to determine how videodisc technology can be applied to storage of personnel file information, technical reference information, and videodisc automated hard-copy transfer that can be updated periodically.
6. Operational investigations should be initiated on the potential use of videodisc technology for distributed (especially shipboard) consolidation of file and technical reference information, presentation of entertainment, and delivery of instruction.

Competent statistical results of this DELPHI study were generated by the eighty-one participants who had (a) authored publications on the current aspects and applications of videodisc technology, or (b) had direct involvement with videodisc technology manufacturing/production, or (c) were members of professional organizations with declared interests in the development of videodisc technology.

**National Institute of Education (NIE) Task Force on Learning and Teaching Recommendation Study:**

Again as alluded to earlier, changes in the content, scope, and method of education both in and out-of-the-classroom were emphasized in the context of the emerging extensive information, ultra communication world society. This study featured changes in work/leisure, the electronic school, an emerging curriculum for the 1980s, new modes of awareness, both the creation and organization of in and out-of-the-school electronic education and a number of proposed recommendations for NIE consideration (3).

**Implications for the NIE:**

**What Should NIE Do?** The first implication for NIE is negative: Do not assume that "Education Equals Schooling Only," when this enormous amount of education of the whole public by the media is going on outside all the time, and is voluntarily chosen and eagerly devoured.

Spend some appreciable fraction of your money—10%? 20%?—on analysis, conferences, research, and pilot programs of all forms of educational interactions with the Electronic Surround.

**Specific Areas to Stress:**

1. The Electronic Schoolroom. Bring together, catalog, and index all the work, forecasts, and evaluations that have already been made. Examine the barriers, successes and failures, costs (and future costs), and work out a systematic approach for initiating the next round of study, implementation, and assessment. It will probably take years to find out the best methods and mixes and their full potential and long-range consequences. This would therefore require the kind of on-going commitment represented by a whole section or division within NIE, with permanent staff.
2. Curriculum for the New World. In an electronic and computer society, how should we change the curriculum for greatest effectiveness? What could be dropped, or what else should be taught, and how, and how fast?
3. Existing Electronic Media and Inputs Most Effectively in the Schools.
4. Creating new Electronic Education for the Schools and the Public. These are parallel questions for intense debate and conferences and experiments, with close collaboration between forward-looking educators and front-rank media people, but of course the second of these will require much more initial funding and organization and planning. It is quite a separate question from (1) above, and would of course require an even larger section or division within NIE, and permanent staff.
5. Full Use of the Resources of Our Present System and of the Media, to Transform to a Whole System for the Continuing Education of the Whole Society. The first steps toward this transformation could grow out of the work in area (4) above, which might become a major part of the work and organizational structure of NIE in 10 or 15 years, as the older forms of education merge into the new. But of course this total educational transformation is too large for any single agency, and will require loose networks of dozens or hundreds of organizational units working at different levels or on different aspects of the total program. What NIE can do is to provide leadership and awareness of this shift toward whole on-going education, and to serve as a channel for catalytic funding, a communications center and clearing house.
6. But just being aware of the possibility of (5), of how fast we are moving toward a continual-education self-transforming society, already takes us halfway toward understanding and solving the thousand other problems of this difficult transition period.

**Microcomputers and Videodisc Systems:**

An earlier cited literature source, Ludwig Braun (1), Director for Educational Technology of the National Coordinating Center for Curriculum Development, State University of New York - Stony Brook, has evaluated the present state of videodisc/microcomputer development, and he projects the educational interfacing potentiality. Identified factors which inhibit the entry of these technologies into education included: limited teacher preparation, availability of reliable systems with accompanying courseware, and the physical system size with cost considerations. In addition, suggested developmental areas and educational implementation strategies for a positive impact upon these technologies were listed for possible private sector and federal agency involvements.

**Braun's Conclusions:**

> Persons find themselves in a very difficult situation in educational technology, in general, and in computers in education in particular. The pace of technological development is acclerating; the cost, reliability, and performance of microcomputers are improving at a phenomenal rate. During the same period of time, as computers are at last within reach of most teachers, funds for support of development of curricular material and educational research in this area have essentially dried up in both governmental and private sectors.
>
> Several aspects of the solutions to the problem of encouraging penetration of technology into the educational system have been identified. These solutions involve substantial levels of financial support—support which must be made available for extended periods (perhaps five years, and certainly no less than three) if satisfactory results are to be expected.
>
> It is difficult to estimate the necessary financial commitment required; however, an amount in the order of one-two million per year appears to be the proper order of magnitude.
>
> Another question of some importance which needs to be addressed is the structure of the effort to be mounted. There appear to be two reasonable possibilities: the establishment of a small number (perhaps two or three) of major centers for computers in education, or the support of five to ten groups nationally. In either case, it is essential that the groups which are established remain in close contact with one another and that there be rapid communication of findings to the educational communty.

**Videodisc Motivations and Deterrents:**

In a 1978 paper prepared for the NIE, Dr. Lester Eastwood (4), Associate Director of the Center for Development Technology, Washington University - St. Louis (Missouri), has evaluated the eductional implications of the "intelligent videodisc." He has defined "intelligent videodisc" as a combination of an advanced microprocessor, a television display, and dense storage technology capabilities which contain the potential for developing into a powerful instructional delivery system. In an inexpensive package, this proposed instructional system could combine advanced computer-aided instruction (CAI), PLATO courseware, a cursor, and a typewriter to permit student interaction. In addition to the CAI format, the system could also support still picture or motion picture television, and normal or compressed audio. In contrast to existing, large-scale CAI systems, this proposed personal scale system could be purchased locally by any single teacher or administrator. Another unique attribute of this technology would be a potential attractiveness to consumers, thus accelerating school implementation.

Despite these unique characteristics, this new technology could experience similar barriers to educational innovation as its predecessors; classroom teachers could be permeated by an uneasiness and general unwillingness with regard to educational technology implementation. Tighter budgets could undoubtedly increase because of shrinking student populations and "Prop 13ing's" and "Jaws II" voter referenda. Furthermore, escalating inflationary costs could restrict available systems and courseware availability.

**The Promise and Inevitability of Videodisc Systems in Education:**

Dustin H. Heuston (5) has advocated that videodisc technology carries great promise for coping with current and future educational problems. This individualized study format has the instructional strength of books, motion pictures, television, and the computer. The videodisc can become a highly effective method of instruction; however, the eventual governmental funding of research, development and implementation is crucial for the advancement of educational uses. Heuston's paper includes a detailed description of the technical aspects of the videodisc, a mini-discussion of the strengths and weaknesses of a variety of educational technologies and cost analysis for the proposed interactive courseware.

**Interactive Videodisc System for Education:**

Bennion and Schneider (6) of Utah's Brigham Young University (BYU), Instructional Research, Development and Evaluation Center, conducted earlier videodisc technology research. Their studies conclude that the basic design of videodisc technology has revolutionary applications for individualized, interactive instruction. The features of the freeze frame, electronic address (individual frame numbers) and the fast random access provide for playback modes for home movies and television rerun entertainment, the optical (laser produced) videodisc is capable of providing branching capabilities because of the random access and electronic location addressing features. The system is also able to accommodate psychological procedures for enhancing learning, such as the capability of inserting questions within still frames or aural modes at any point. Specific features that are extended by this interactive videodisc system outweigh an earlier initiated BYU system—Time Shared Interactive Computer Controlled Instructional Television (TICCIT). The new videodisc interactive system extends motion image control, greater audio capabilities and eliminates the need for an external computer.

**Applications of Videodisc Technology to Individualized Instruction:**

Schneider (7), in a presentation at the National Science Foundation Education Directorate Conference for a ten-year forecast for computers and communications, related videodisc implications probable for education. This BYU study focused upon the cost economics and highlighted the educational use of videodiscs.

**Economics of Videodiscs:**

Schneider, with the assistance of his BYU colleagues, projected several cost comparisons which dramatize videodisc advantages:

**Table 1**

Videodisc: Reproduction Equipment Cost Comparisons

Cost of Media Reproduction Equipment

| | |
|---|---|
| 1. 8mm video player and monitor | $1,592.00 |
| 2. 3/4" videotape cassette player and monitor | 1,500.00 |
| 3. Optical videodisc player and monitor | 900.00 |
| 4. 16mm projector and screen | 825.00 |
| 5. 8mm projector and screen | 554.00 |

Each video system included the costs of a color monitor and each motion picture system included the cost of a screen.

The second table compares the per-copy cost for 1, 10, 100, and 1,000 copies of a 30-minute program. The videodisc individual copy cost is drastically reduced with volume.

**Table 2**

Per Copy Costs, One-half Hour Motion Visual Program

| | Quantity | | | |
|---|---|---|---|---|
| **Medium** | **1** | **10** | **100** | **1,000** |
| 16mm film | 417.00 | 108.00 | 84.52 | 66.17 |
| 8mm film | 205.00 | 66.00 | 52.00 | 44.76 |
| 3/4" video cassette | 70.00 | 31.00 | 21.25 | 18.50 |
| Videodisc | 450.00 | 46.00 | 3.01 | .63 |

Because of the freeze-frame capabilities, Table 3 emphasized the cost advantage of videodisc in comparison with other still-frame media.

**Table 3**

Per Frame Costs (in dollars) for Still Visuals (54,000 frames per set)

| | Quantity | | | |
|---|---|---|---|---|
| **Medium** | **1** | **10** | **100** | **1,000** |
| 35mm color slides | 0.25 | 0.20 | 0.15 | 0.09 |
| 35mm color filmstrips | 0.122 | 0.02 | 0.0085 | 0.0085 |
| Microfiche, color | 0.15 | 0.022 | 0.0083 | 0.0083 |
| Microfilm, monochrome | 0.10 | 0.017 | 0.0076 | 0.0076 |
| Videodisc | 0.0083 | 0.0009 | 0.00006 | 0.00001 |

Schneider combined these cost estimates and projected cost comparisons for an educational network of one hundred elementary schools in a two-hundred square mile radius. Each school population numbered 550 students. Each school had the capability of viewing six different programs simultaneously and accessing two hundred 30-minute programs. Each program was shown an average of four times each year. The initial system outlay amortized over a five-year period provided yearly costs for the competing alternative delivery system as Table 4 reflects:

**Table 4**

Annual Costs (in thousands of dollars) for an Education Network (group viewing)

| | Year | | |
|---|---|---|---|
| **Medium** | **1-5** | **6-10** | **Total-10 Year** |
| Local Libraries | | | |
| 3/4" videotape | 314. | 48. | 1,570. |
| 16mm film | 437.4 | 39. | 2,382. |
| Videodisc | 168. | 48. | 1,080. |
| Networks | | | |
| CCTV 3/4" videotapes | 310.36 | 116.2 | 2,383. |
| CCTV (videodiscs) | 247.8 | 96. | 1,239. |
| 16mm film lending library | 182.36 | 79.6 | 1,310. |

Schneider pointed out that this projected network saved $23,000 a year by providing a videodisc library for each school instead of administering a conventional film distribution system. If the schools establish a closed-circuit television system, administration could reduce the annual cost by 42%, if they provided videodiscs in place of videotapes.

**Educational Uses of Videodiscs:**

Judging by the cost figures shown above, it will only be a matter of time until videodiscs completely replace conventional motion pictures in educational institutions. This is especially true if projection television displays become just a bit cheaper.

Another and more innovative possibility is the use of videodiscs to replace the monochrome postcard reproductions that fine-arts students buy, and the sets of microscope slides that are inflicted on students of medicine and life sciences. Videodiscs will be used as image banks for both still and motion sequences. For example, it will be possible when studying dynamic systems such as the growth of an embryo or the oscillations of a mechanical system, to record different views of the same process on adjacent videodisc tracks, and to switch from one viewpoint to another by pressing buttons on an external keyboard. This capability would allow the student to manipulate, at least in a crude way, the material under study.

Videodiscs would also replace the ubiquitous slide/tape shows. In order to provide audio, the videodisc would work in a normal "motion picture" manner when audio was required. When audio was not required, a still-frame or a sequence of still-frames could be shown. The still-frames would contain study questions, discussion points, or summaries, and the video player would continue to show them until it received a command to go on.

More sophisticated interactive applications would require the addition of a more elaborate keyboard and a microprocessor to control the videodisc player. We are in the initial design phases of specifying not one, but a family of interactive machines that are capable of varying degrees of processing a student's answer. The simplest machine would accept multiple choice answers (A, B, C, D) and would branch to a specific frame, depending upon which answer was selected. With the addition of a small amount of memory, such machines would work well in adaptive testing applications, where the selection of the next test item depends upon the response history of the student up to that point. A little more memory, say on the order of two to four thousand words, and a simple character generator to display about fifty characters of student input, would allow the videodisc system to support a slightly modified version of the learner-controlled computer-assisted instruction.

In another earlier BYU study, Bennion (8) described possible applications of videodiscs to individualized instruction systems. He emphasized that the videodisc with random access and large capacity for storage of high quality educational media has the potential of becoming an effective new medium for individualized interactive instruction at low cost. The best available instructional psychology and learning theory should be sought so that the full potential of the videodisc can be realized. New techniques for lesson development utilizing interactive control of still frames and motion sequences need to be explored. Learner control of freeze frame, slow motion or fast motion options during motion sequences by repeating or skipping revolutions is possible with the videodisc system and needs to be evaluated.

**Videodisc Technology: Its Potential for Libraries:**

Gray (9) projected the effects of future large-scale videodisc production with great potential for school and public libraries. A single vieodisc could contain more than 200 books with two text pages per frame. He has documented the competition between Magnavox and RCA to market the first U.S. system. Implications of the videodisc for libraries are: (a) more access to 16mm films; (b) low-cost slide collections; (c) more television programs on disc; (d) storage and retrieval possibilities; (e) versatility in instruction; (f) the throw-away television program; (g) audio flexibility; and (h) periodicals on discs.

**LeVideodisque: General Considerations and Areas of Application:**

Broussaud (10) has identified and analyzed the definition of a videodisc system and particularly the optical approach opportunities of this system. Special mention was made of the access to information on both sides of the transparent disc. Finally, potential markets were considered for videodisc technology with consideration of the remarkable properties of this new communication/instructional medium.

**Conference on Intelligent Videodisc Systems:**

Bork, Luehrmann and Schneider (11) co-directed a three-day conference to formulate a plan for the development of the necessary videodisc equipment and the possible production of commercially available courseware. Those attending the conference included persons from academic institutions and similar organizations concerned with using computers as educational tools, developers and manufacturers of computer equipment, developers and potential manufacturers of the videodisc technology, and representatives from governmental agencies. Activities included presentations of informal review papers, small group discussions and reports, and demonstrations.

**Mission of the Future:**

Proceedings of the annual convention of the Association for the Development of Computer-Based Instructional Systems (12) are available in three volumes. The general session opened with seven papers on various aspects of videodisc technology. Intelligent instructional systems, learning theory, evaluation, training teachers and administrators in computer applications, learner interaction with computer assisted instruction, course development, authoring, and the application of bibliographic information retrieval techniques of videodisc/computer materials are included.

**Videotex: Words on the Television Screen—Viewdata, Teletext and the Rest:**

Howkins (13), representative of the International Institution of Communications, London, England, focused on Videotex. This is the development of telephone-based systems that use television sets and the telephone with the addition of a simple keyboard to access bands of information available on computers and to receive information in print on television screens. A series of articles are included on Prestel, a telephone-based videotex service in operation in the United Kingdom; the role of the United Kingdom Post Office as the Prestel carrier; the different ways in which infomation providers are using the medium; plans for videotex in Canada, France, Japan, and Germany. Possibilities for the future development and uses of videotex systems, also referred to as viewdata, teltext, videotext and Text-TV, are discussed.

**A Study of Authoring Alternatives for Training-Oriented Videodiscs:**

Bunderson, Jarvis and Mendenhall (14) have addressed eight areas that are related to "authoring" problems. These include the delivery system (i.e., the various capabilities of videodisc players and associated computer devices), media selection during instructional systems development, instructional strategies, author mock-up and simulation prior to premastering, premastering, mastering and replication, composition of videodisc authoring teams, and evaluation alternatives. They concluded that optical videodisc technology and the authoring technologies associated with it are still in a state of flux and are expected to be changing and evolving during the next five years. This study recommended delaying wide deployment of videodiscs for Navy training in the immediate future but at the same time those agencies interested in videodiscs should track the development of knowledge in the field, which is expected to unfold rapidly in the early 80's.

**Videodisc Standardization: Presently, the Horns of a Trilemma:**

The list of videodisc player manufacturers is extensive. In the mid-70's, twenty-six different videodisc systems were demonstrated at a "Video Discs" conference in London, England. During the latter part of 1980 or early 1981, Matsushita, the **third** U.S. videodisc standard marketing agency will introduce this non-germane standardization, incompatible with either the RCA or MCA-Magnoavox standards. The Matsushita disc, VHD (very high density) standard was engineered by the Victor Company of Japan, Ltd., which Matsushita partially owns, and is known in the U.S. as JVC. With 1980 marketing plans, Matsushita, in adopting the JVC videodisc system, has virtually abandoned its earlier developed Visc-o-Pak system.

**The Matsushita JVC Videodisc System:**

JVC has supplied their original concept specifications for the "VHD (video operation)/AHD (audio operation)" System. With these preannounced unique features, Matsushita is hoping to gain support to forward standardization of the JVC VHD/AHD System. This VHD player is expected to be priced competitively with the RCA system, around $500, and extends a more economical, readily accessible disc duplication process.

To be Marketed by Matsushita

New video disc technology—JVC Video/Audio High Density Disc System "VHD/AHD"

Several combinations of the JVC video disc player and auxiliary units provide different video and audio functions. The video operation (VHD) features special image effects (still, slow, quick motion, and back and forth). The system is capable of locating a preselected single track for automatic playback in preprogrammed order by a user, including various special effects. The audio operation (AHD) features super hi-fi stereo music. Wireless control of the random access unit by a remote control unit is available.

**Features of the "VHD/AHD" System:**

1. Picture and sound information including stereo are recorded as pits on the disc surface without grooves to quide a pick-up stylus. The disc which rotates at a constant speed of 900 rpm, is capable of playing a one-hour long program per side. (Total two hours for both sides.)
2. Picture and sound information including stereo are recorded as pits on the disc surface without grooves to guide a pick-up stylus. The disc which rotates at a constant speed of 900 rpm, is capable of playing a one-hour long program per side. (Total two hours for both sides.)
3. For recording, a single laser beam is split in two, one-half for recording information to be retrieved, the other for recording the tracking signal.
4. Information and tracking signals are simultaneously picked up electronically as capacitance variations between the disc surface and an electrode on the tracking stylus.
5. The cantilever arm which holds the stylus is servo-controlled to track the imaginary grooves on the disc, and to correct for the time base error of the rotating disc by an Electro-Tracking System.
6. There are no actual mechanical grooves on the disc's surface to guide the stylus; instead, the stylus merely slides along the surface and is guided electronically to pick up the recorded signals. This feature enables the pick-up arm to move freely over the entire surface of the disc, and permits special effects such as random access, still, slow and quick motion to be achieved. The sliding stylus, therefore, has ten times the contact area that a similar "stylus-in-a-groove" system has. This prolongs the life of both the stylus and the disc.
7. Electro-conductive PVC plastic disc material requires no additional processing after being pressed. Recording is performed using a master disc made of glass by means of a special recording device installed in a clean room. The smooth, flat glass disc is coated with ordinary photosensitive material. While rotating at a speed of 900 rpm, minute laser beams are irradiated onto the disc, the source of the beams moving radially at a constant speed. As a result, fine pits are recorded spiraly on the glass disc. Again, the laser beam is split in two, one-half for the information signals, the other for the tracking signals. The information and tracking pits are recorded simultaneously by these beams. A metallic master disc is produced from the glass master disc by the conventional audio process, thus reducing the mastering costs.

Several combinations of the player and auxiliary units provide different video and audio functions. In the case of video operation (VHD), Normal (back and forth), Special Effect (still, slow, quick motion; back and forth) and Fast Search (back and forth) modes are performed by the player itself. The system is capable of locating a preselected single track so that recorded materials can be played back automatically in preprogrammed order by a user, while incorporating any special effect modes selected. In the case of audio operation (AHD), super hi-fi stereo music can be enjoyed by connecting the PCM decoder to the player. In conjunction with the random access unit, the system plays music recorded on the disc automatically searching programs preselected by a user. Wireless control of the random access unit by a remote controller is available. As mentioned above, connecting the desired unit to the player can add uniquely different functions to both video and audio operations.

**The RCA VideoDisc System—SelectaVision:**

In late 1980 or early 1981, RCA is expected to market their $500 videodisc player. The unit is expected to provide a better quality picture than the home VCR and also extend stereo sound. Unlike the Magnavision videodisc player, the RCA unit lacks slow-motion, stop, reverse and frame addressing capabilities. The RCA player, however, does provide instant search and instant replay features in the two-hour mode. The physical information density is almost one hundred times as high as for magnetic discs for computer applications and about ten times greater than for videotape.

RCA's early research on capacitance (stylus in groove) playback systems predates the announcement and demonstration of pressure pickup systems and optical videodisc formats. The **RCA Review** related that most of RCA's developments occurred after analyzing other videodisc approaches and concluding the capacitance tecnology could achieve a most favorable balance of features, cost, and performance for the discs and players.

The RCA system features disc loading through a slot in the front of the unit. The disc is plastic and is encloso a "caddy" package slightly over twelve inches square from which it is extracted once inside the enclosed player. Disc playing time is two hours and the image compares with the best possible television reception. The March 1978 issue of the **RCA Review** exhaustively documents the "RCA's VideoDisc" technology research and development.

RCA expects to sell 200,000 units during 1981 and predicts that from thirty to fifty percent of American homes with color television will obtain the videodisc unit during a seven-year period. The initial RCA VideoDisc catalog will list about 200 disc titles with approximately ten new releases to be added each month. Half of the programs will be feature films while the balance will be comprised of pop music, children's programs, sports, educational and cultural enrichment titles. Most of the discs will sell at a cost between $15 and $20 with shorter educational titles selling for less.

**The MCA-Philips-Magnavision Videodisc System—The U.S. Market Pioneer:**

An extensive volume of literature has been published concerning the MCA-Philips (optical) videodisc player which is being manufactured and distributed by Magnavox. This optical system operates on the same principle as the French Thomson-CSF unit which utilizes laser reading of a video signal encoded in tiny pits of varying dimension pressed into a plastic disc. The Magnavision system offers two speeds plus several instructional frame access options:

1. Still; Reverse/Forward
2. Slow Motion; Reverse/Forward
3. Slow Motion; Variable Slider
4. Play; Reverse/Forward
5. Fast; Forward
6. Audio; Channel One/Channel Two
7. Search; Reverse/Forward
8. Index (Addresses 54,000 frames per thirty-minute capacity side)

"Magnavision" was initially introduced in two test markets: Atlanta and Seattle-Tacoma. In the spring of 1980, these test markets were expanded to include Dallas. In addition to selling the videodisc system, the Dallas test market will assess disc rental vs. sales; videotape vs. videodisc rental and sales; and videodisc sales and rental conducted by the Fotomat Kiosk network.

**MCA-Pioneer DiscoVision Industrial/Educational Player:**

The MCA DiscoVision model PR-7820 was designed especially for instruction, training, and information applications. This laser optical videodisc player is compatible with the Magnavision consumer standard and performs all of the manual frame access functions listed earlier. This unit provides various levels of program use capabilities:

1. Constant linear velocity
2. Manual frame access
3. Automated frame access
4. Programmable sequence access
5. Pre-programmed sequence access

These functions extend opportunities for creative program production and interactive instructional programming. Investigations into instructional methodology, strategies, economics and efficiencies of the videodisc system are referred to as "videodisc authoring techniques."

This industrial/education videodisc system is being implemented in General Motors showrooms as an innovative video network and as a customer sales tool. GM has reportedly placed an order for at least 8,000 units at an estimated cost of between $2,000 and $3,000 per system. These units will be the first debuted videodisc machines in many U.S. regional system. These units will be the first videodisc machines in many U.S. regional communities and will constitute substantial general public exposure to further promote the MCA optical videodisc standard.

Late in 1979, IBM and MCA DiscoVision, Inc., formed a joint business venture creating DiscoVision Associates. Universal-Pioneer, the earlier joint venture of MCA's Universal Division and the Japanese Pioneer Electric Corporation, produced the industrial/educational videodisc system. DiscoVision Associates' foremost goal is to continue the initial MCA-Pioneer thrust of developing, manufacturing and marketing the optical videodisc standard exclusively for industrial sales. Currently, IBM Corporation is field-testing the DiscoVision players at selected training locations. If this communication/training experiment is successful, IBM could convert its eight-year-old network of 2,000 U-matic players to the optical, interactive videodisc standard.

DiscoVision Associates, a joint venture with the collective entities of MCA-Universal, Pioneer, and IBM, is reportedly planning to manufacture a compatible consumer version of its system which should further public acceptance of the MCA-Philips optical disc standardization.

**The Future:**

Bob Paulson (15), Society of Motion Picture and Television Engineers' (SMPTE's) Videodisc Study Group has written that from the manufacturer's standpoint there will be a unified videodisc standard with substantial business in player and disc sales in the U.S. He predicts that the standard will be labeled EIAJ, and the players will be manufactured chiefly in a foreign (Japan) country. However, from the user's point of view, as many as five or six standards could exist side by side. The three levels of application which have been recognized by all of the announced Videodisc manufacturers include:

**Consumer** - the random access playback only, continuous or single frame viewing;

**Institutional** - the random access playback only, continuous or single frame viewing, plus viewer interaction with the system;

**Professional** - real-time continuous or interrupted recording, but not including erase and re-record capability, and random-access continuous or single frame playback.

Paulson predicts that the U.S. videodisc demand will be satisfied with tens to hundreds of thousands of units in use within the 1985-1990 time frame.

**Emergence of Videodisc Erase and Re-record Capability:**

Aside from the present relatively high cost of the videodisc player units, another disc limitation is the current inability to satisfactorily erase and re-record data, in contrast with videotape systems which have this capability. However, this inability to record with optical disc ystems is a temporal problem and is in part being resolved by Dr. John Locke, formerly affiliated with the University of Toronto. He has perfected a laboratory operational model of an erasable, re-recordable videodisc system.

Philips Laboratories (16) has announced development of a prototype erasable disc which purportedly is in an advanced state of overall development for computer access and eventual consumer, industrial, and professional purposes.

The major challenge faced by Philips Laboratories engineers has been to develop an inexpensive videodisc digital information recorder. The rapidly reduced cost of digital processing has been responsible not only for a change from analogue to digital processing, but also has enabled more complex processing to be carried out economically. Digital processing offers flexibility and accuracy with the ability to store information reliably for very short or extended periods of time.

This specially designed Philips disc enables the operator to record in an ordinary room, not the usual ultra-clean laboratory environment required for minute dust/lint control. The Philips Air Sandwich, a disc protective mechanism, in essence contains a miniature "clean room" in the annuler cavity between the two outer discs (Figure 1). While a clean room has been unnecessary for both the Locke and Philips laser recording equipment, protection from scratches, dust, and fingerprints is required before, during, and after the recording process.

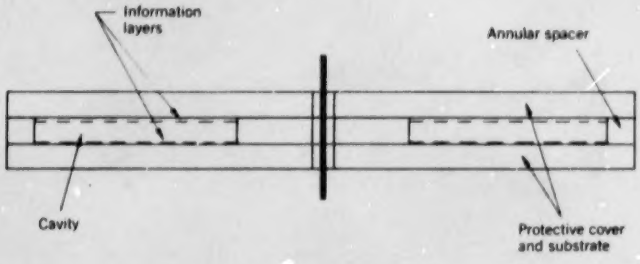


Figure 1

A disc-protection mechanism trade-named Philips Air Sandwich contains a miniature "clean room" environment in the annular cavity between the two outer discs.

(Copyright © 1979 by Institute of Electrical and Electronics Engineers, Inc. Excerpted by permission from **IEEE SPECTRUM**, Vol. 16, No. 2, February 1979, and optical disc developers Philips Laboratories, North American Philips Corporation—George C. Kenney, David Y. K. Lou, Robert McFarlane, Albert Y. Chan, Joseph S. Nadan, Thomas R. Kohler, John G. Wagner and Fritz Zernike.)

The Philips patented "self-developing" digital disc is based on laser-forming of pits in a thin metallic film. Tellurium and bismuth were determined to be the most acceptable recording substances. Various raw materials were considered for the Philips disc substrate and its initial as well as eventual protection qualities. Material selection was based primarily on macro and microscopic flatness, thickness uniformity, strength, optical properties, cost and adherence to recording film. Plexiglas was selected as the primary disc base. Tellurium-based film was rated as the most attractive recording medium based on sensitivity, resolution quality, reproducibility excellence, and archival storage capability (Figure 2).

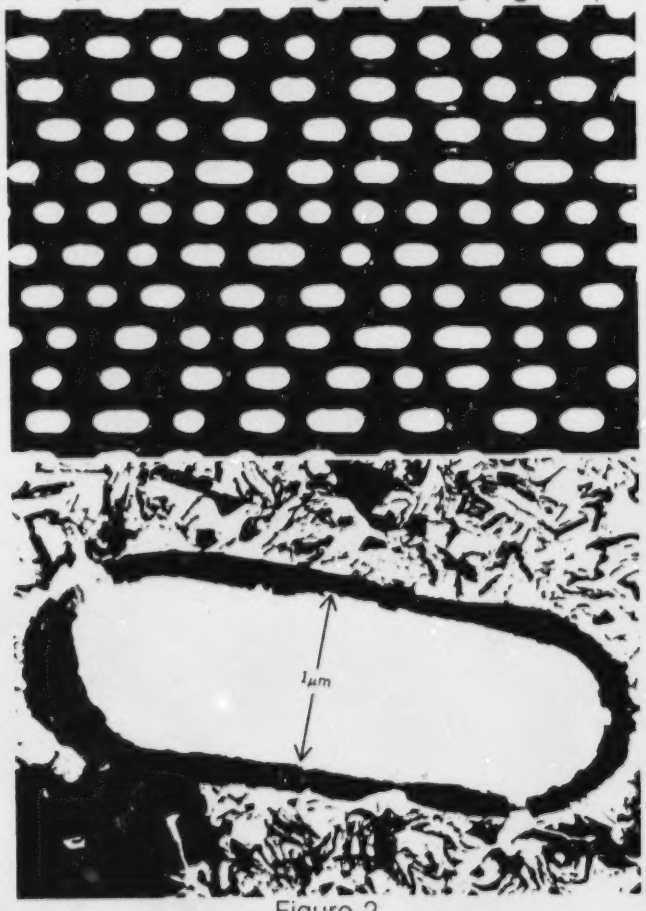


Figure 2

A tellurium-based film was chosen as the most attractive recording medium, based on the requirements of sensitivity, resolution qualities, reproducibility, and archival storage. The optical and mechanical properties of the tellurium disc are comparable to those of the 12-inch consumer videodisc. A cost of $10 per disc is anticipated.

(Copyright © 1979 by Institute of Electrical and Electronics Engineers, Inc. Excerpted by permission from **IEEE SPECTRUM**, Vol. 16, No. 2, February 1979, and optical disc developers Philips Laboratories, North American Philips Corporation—George C. Kenney, David Y. K. Lou, Robert McFarlane, Albert Y. Chan, Joseph S. Nadan, Thomas R. Kohler, John G. Wagner and Fritz Zernike.)

An increase of power to the laser enables it to record data by melting microsized holes into a tellurium-based recording material that can be read immediaely as a reflection. A pre-grooved track having a depth of one-eighth of a wavelength enables the system to find and read data address headings; thereby data can be recorded anywhere on the disc recording area and can be retrieved almost instantaneously. Only approximate indications can be extracted currently from the laboratory accelerated aging tests. For the projected archival needs, testing results indicate a normal shelf life of ten years at average room temperature. Tellurium film samples were found to have stable color resolution qualities at the following test temperatures: 25°C, 55°C, 75°C, and 90°C.

With a high accuracy servo-mechanism, the maximum time needed to gain access to the equivalent of six magnetic disc packs is only 500 milliseconds. A projected design for a disc pack with six double-sided discs and one of the optical heads (Figure 3) has been created by Philips Laboratory. Another one of their designed access systems makes use of a "juke box" (Figure 4) to retrieve images from 1,000 or more separate discs.

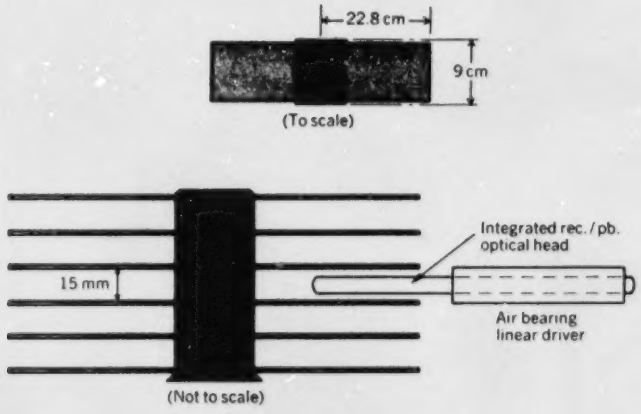


Figure 3

Basic design of an optical disc pack with six double-sided videodiscs provides storage capacity of one trillion bits.

(Copyright © 1979 by Institute of Electrical and Electronics Engineers, Inc. Excerpted by permission from **IEEE SPECTRUM**, Vol. 16, No. 2, February 1979, and optical disc developers Philips Laboratories, North American Philips Corporation—George C. Kenney, David Y. K. Lou, Robert McFarlane, Albert Y. Chan, Joseph S. Nadan, Thomas R. Kohler, John G. Wagner and Fritz Zernike.)

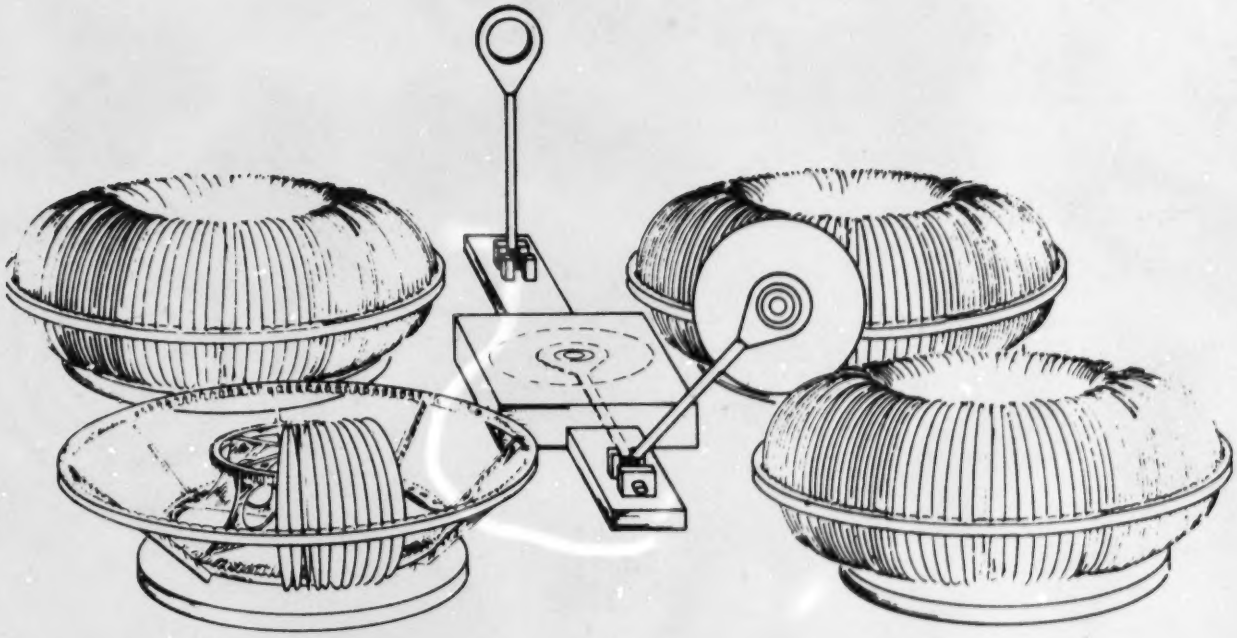

Figure 4

Concept of an automatic optical disc changer system with four lazy susans will provide access to 1,000 videodiscs.

(Copyright © 1979 by Institute of Electrical and Electronics Engineers, Inc. Excerpted by permission from **IEEE SPECTRUM**, Vol. 16, No. 2, February 1979, and optical disc developers Philips Laboratories, North American Philips Corporation—George C. Kenney, David Y. K. Lou, Robert McFarlane, Albert Y. Chan, Joseph S. Nadan, Thomas R. Kohler, John G. Wagner and Fritz Zernike.)

The need to store and retrieve large quantities of information in the form of either video or binary data is generating much activity in high-speed, mass-storage media. Optical disc recording is attractive as a storage medium because of the high recording density and the reliable archival storage qualities.

Commercial use of the Philips Erasable Disc is still approximately two years or more in the future and will begin by competing with current computer disc and tape retrieval data systems. The Philips erasable disc machine or a similar play/record system could emerge in a consumer version within four to six years. A commercial erasable disc could undoubtedly have significant effect on both photographic (e.g., microfilm, motion film, etc.) and magnetic (e.g., videotape recorders and computer disc) manufacturers. The erasable disc could significantly increase the application of videodisc and may eventually (within ten years) supplant most videotape machines. Even ordinary consumer photography, medical photography and publishing could be greatly affected. For example, snapshots, slides, motion film and X-rays now stored in bulk form could be recorded and preserved by the thousands on one disc without deterioration of color or other qualities. Increasing silver commodity prices could rapidly escalate the future development and distribution of video technologies.

**Other Futuristic Storage/Retrieval Developments:**

The microcomputer rage has been recently labeled the era of the personal computer. The videodisc systems which have been discussed earlier have a great potential for educational use as stand-alone units or as part of an information-processing system interfacing with a computer. The University of Utah Video Computer Authoring System (17) is being adopted by an increasing number of educational agencies. This system contains a set of programs, written for the most part in UCSD Pascal (® Trademark, Regents of the University of California) which permits instructional designers to efficiently create and edit computer-aided lessons utilizing video interfacing while eliminating the need to write computer programs for each set of lessons. The interactive lessons include text, graphics, animation, segments on videotape, and more recently, videodisc segments.

Recent computer and other technological developments have demonstrated further extensive improvement capabilities with magnetic recording principles will be increasingly difficult to obtain (Figure 5). Alternative high speed, dense-storage media systems that are economical, compact, archival and extend random access capabilities are consequently required (Figure 6).

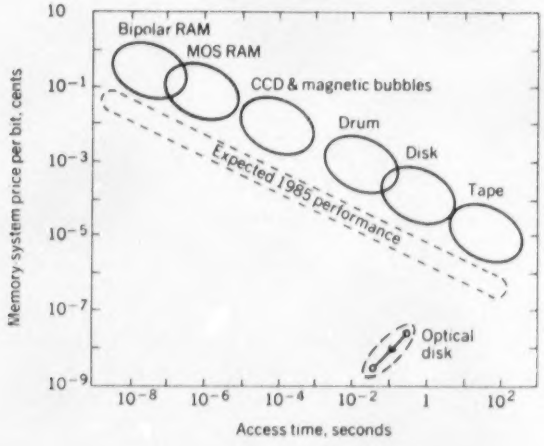


Figure 5

Recording density (volume) vs. time for the various recording media illustrates that the optical disc limit exceeds that for magnetic recording.

(Copyright © 1979 by Institute of Electrical and Electronics Engineers, Inc. Excerpted by permission from **IEEE SPECTRUM**, Vol. 16, No. 2, February 1979, and optical disc developers Philips Laboratories, North American Philips Corporation—George C. Kenney, David Y. K. Lou, Robert McFarlane, Albert Y. Chan, Joseph S. Nadan, Thomas R. Kohler, John G. Wagner and Fritz Zernike.)

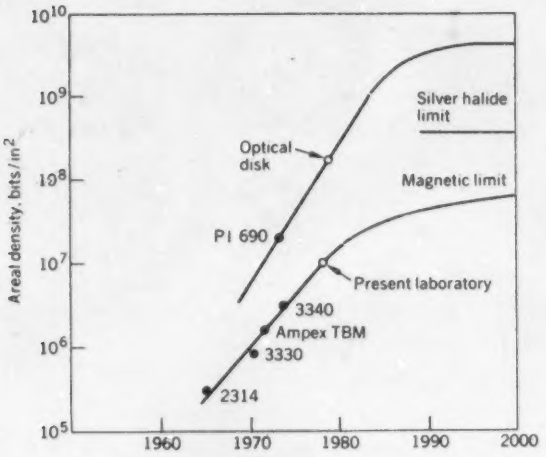


Figure 6

Access time vs. price for various storage technologies places the optical videodisc in a favorable position.

(Copyright © 1979 by Institute of Electrical and Electronics Engineers, Inc. Excerpted by permission from **IEEE SPECTRUM**, Vol. 16, No. 2, February 1979, and optical disc developers Philips Laboratories, North American Philips Corporation—George C. Kenney, David Y. K. Lou, Robert McFarlane, Albert Y. Chan, Joseph S. Nadan, Thomas R. Kohler, John G. Wagner and Fritz Zernike.)

Futuristic alternative "memory/delivery" systems that are rapidly becoming available for learning system development, will undoubtedly feature highly sophisticated random access memory (RAM) specifications, phenomenal dense storage charged coupling devices (CCD)/magnetic bubbles, and extremely individualized bipolar solid state capabilities. Spurringmost incomprehensible technological era are:

1. An emerging lucrative consumer market;
2. The commercial broadcating technology needs;
3. U.S. political supremacy needs among other world powers; and
4. Various comunication needs with storage and then rapid retrieval for large quantities of data (e.g., text, motion picture image/sound, microprocessing, etc.)

Braun (1) has identified major predictions about the nature of future technological developments.

1. Alpha Data Inc. of Chatsworth, California, has announced a charge-coupled-device (CCD) solid-state "disc," called the CCDISC. Its average access time is 250u seconds, and its capacity is 128 K byte-IM byte. In small quantities, an IM byte unit costs $17,000 or 0.2¢/bit.
2. Panigrahi (18) describes a variety of applications and configurations for CCD and bubble memories. He points out that these systems "are not direct replacements for discs, but rather new system components . . . ."
3. Noyce (19) predicts 65K bit-131K bit memory chips with 100 nano-second access time by 1981, and IM bit chips by 1985.
4. Petritz (20) predicts a single-chip 32-bit processor with IM bit of memory on board by 1985.
5. John and Volk (21) describe a complete microcomputer built from only three chips. This computer has an 8080-type processor, a serial and multiport-parallel I/O interface, interrup controller, timer, 256 bytes of RAM, and 2,048 bytes of ROM.

6. Japan will seriously challenge the U.S. semiconductor industry in the near future. Among their developments are:
   a. 10K-50K-gate chips and IM bit memory chips are under development.
   b. Their LSI chips cost only 40% of U.S. units.
   c. They are spending $250M-$1.5B on developments in IC components.
   d. 262K bit RAMS and one-chip 32-bit microprocessors (with 32K bytes of on-board RAM) by 1981-83.
   e. 65K-bit RAM chips and 16-bit microprocessors 4K byte on-board RAM by 1979.
7. Hitachi of Japan (22) has under development an LCD panel with four rows of 32 characters using a 5x7 dot matrix on a panel 38mmx175mm (1.5 in. x 7 in.), and soon will have an 8-row unit.
8. Texas Instruments (23) has a 92-bit bubble chip available which is already cost competitive with floppy discs. In quantity, a bubble chip interface costs $75. Bubble memories have higher reliability and lower error rate than either fixed-head or floppy discs. They also have faster access time, lower power requirements, smaller physical size and simpler interfacing; but have lower transfer rate than floppy discs. In addition, to change the data set to be accessed on a disc, one need only change the diskette which costs only $5; whereas changing a bubble chip still is quite difficult and expensive. A bubble "disc" is compared with the Shugart mini-floppy disc in the table below:

| **Characteristic** | **Bubble "disc"** | **Shugart** |
|---|---|---|
| Cost incl. interface | 0.08¢/bit | 0.03¢/bit |
| Transfer rate | 44K bits/sec. | 125K bits |
| Avg. access time | 4 ms | 463 ms |
| Weight | 0.7 lb. | 3 lbs. |
| Volume | 38 cu. in. | 150 cu. in. |

9. Philip Roybal of National Semiconductor feels that there will be plug-in bubble memories by 1981.
10. Jim Warren, the editor of Dr. Dobb's Journal of Computer Calisthenics and Orthodontia in Menlo Park, California, predicts that:
    a. Magnetic bubble and CCD memories will replace floppy disc within two years.
    b. There will be networking of personal computers for memory sharing, program files, etc.
    c. Personal computers will serve as communication channel for handicapped people.
    d. Computer system prices may not drop in the future, but system capabilities will increase. Chuck Peddle of Commodore (designer of the PET) agrees. He points out that the cost of black-and-white monitors, cassette recorders, and keyboards are as low as they are likely to get; so they place a floor under prices of systems.

e. Speed increases by a factor of 10 will give us real-time graphics and speech synthesis.

f. New display technologies will emerge (flat-screen and LCD).

g. Better languages will be developed.

11. Alan Kay of Xerox Research suggests that RAM may be in head-to-head competition with bubble memory for mass memory. The volatility of RAM may be overcome relatively easily as standby power requirements drop. Battery back-up power makes them essentially non-volatile.

12. A holographic microfiche read-only-memory system has been announced with 25M byte capacity, and with a projected retail cost of $500.

**A Summary: Possible Symbiotic Relationships**

The dramatically different learning environments made possible with microcomputers interfaced with videodisc systems will provide educators with simultaneously exciting possibilities for the improvement of instruction. New emerging authoring systems will further advance the era of "audiovisual instruction" into a most productive period of "educational technology" development. We are moving from a society in which the major focus has been on information **transmission** via books, blackboard, and lectures to one with a focus on information processing utilizing microcomputers, videodisc technology with teachers mediating these symbiotic learning improvement opportunities.

# SELECTED BIBLIOGRAPHY


1. Braun, Ludwig. *Microcomputers and Video Disc Systems: Magic Lamps for Educators?* State University of New York, Stony Brook, ERIC ED 154 839, 77 p., 1977.
2. Daynes, Rodney R. *Videodisc Technology Use Through 1986: A DELPHI Study,* Navy Personnel Research and Development Center, San Diego, California, ERIC ED 145 823, 48 p., December 1976.
3. Plott, John. *Learning and Teaching in the Electronic Society,* National Institute of Education Task Force on Learning and Teaching, ERIC ED 167 120, 10 p., September 1977.
4. Eastwood, Lester F., Jr. *Motivations and Deterrents to Education of "Intelligent Videodisc" Systems,* Center for Development Technology, Washington State University, St. Louis, Missouri, ERIC ED 157 516, 57 p., January, 1978.
5. Heuston, Dustin H. *The Promise and Inevitability of the Videodisc in Education,* WICAT, Inc., Orem, Utah (for NIE), ERIC ED 153 636, 99 p., September, 1977.
6. Bennion, Junius L. and Schneider, Edward W. *Interactive Video Disc Systems for Education,* Division of Instructional Research, Development, and Evaluation, Brigham Young University, Provo, Utah, ERIC ED 158 719, 19 p., October, 1975.
7. Schneider, Edward W. *Applications of Videodisc Technology to Individualized Instruction,* Division of Instructional Research Development and Evaluation, Brigham Young University, Provo, Utah (for National Science Foundation), ERIC ED 158 722, 22 p., September, 1975.
8. Bennion, Junius L. *Possible Applications of Optical Video Discs to Individualized Instruction Systems,* Division of Instructional Research, Development, and Evaluation, Brigham Young University, Provo, Utah (for NSF), ERIC ED 158 721, 10 p., February, 1974.
9. Gray, Robert A. "Video Disc Technology: Its Potential for Libraries," *School Library Journal,* Vol. 24, No. 5, pp. 22-24, January, 1978.
10. Broussaud, G. "Le Videodisque—Generalites et Apercu Sur Ouelques Domaines D'Application," *Review of Technique Thomson-CSF,* Vol. 10, No. 4, pp. 655-680, December, 1978.
11. Bork, Alfred, et al. *Conference on Intelligent Videodisc Systems, Brief Informal Summary,* University of California, Irvine, ERIC ED 163 978, 14 p., December, 1977.
12. *Mission of the Future, Proceedings of the Annual Convention of the Association for the Development of Computer-Based Instructional Systems. Volume I,* San Diego, California, ERIC ED 175 447, 332 p., March, 1979.
13. Howkins, John. *Videotex: Words on the TV Screen. Viewdata, Teletext and the Rest,* Internal Institution of Communications, London, England, ERIC ED 175 064, 57 p., May, 1979.
14. Bunderson, Victor C.; Jarvis, Stanley; and Mendenhall, Robert F. *A Study of Authoring Alternatives for Training-Oriented Videodiscs,* WICAT, Inc., Orem, Utah (for the U.S. Navy Personnel Research and Development Center, San Diego, California), DIALOG File 6: NTIS 64-80/ISS03, 85 p., September, 1979.
15. Paulson, Bob. "What's Ahead for the Videodisc?" *Broadcast Engineering,* Vol. 20, No. 12, p. 56, December 1978.
16. Kenney, George C., et al., "An Optical Disk Replaces 25 Mag Tapes," *IEEE Spectrum,* Vol. 16, No. 2, pp. 33-38, February, 1979.
17. Brandt, Richard C. and Knapp, Barbara H. *University of Utah Video Computer Authoring System, Version 1.6,User's Guide,* University Research Foundation, University of Utah, Salt Lake City, Utah, 1979.
18. Panigrahi, G. "The Implications of Electronic Serial Memories," *Computer,* Vol. 10, No. 7, pp. 18-25, July 1977.
19. Noyce, Robert N. "Large Scale Integration: What Is Yet to Come? *Science,* Vol. 195, No. 4283, pp. 1102-1106, March 18, 1977.
20. Petritz, Richard L. "The Pervasive Microprocessor: Trends and Prospects," *IEEE Spectrum,* Vol. 14, No. 7, pp. 18-24, July 1977.
21. John, D. W. and Volk, A. "Microcomputer Sets Packs It All Into Three Chips," *Electronics,* pp. 109-113, May 12, 1977.
22. *Electronics,* p. 79, June 23, 1977.
23. *Electronics,* p. 81, August 4, 1977.

**For Additional Reading:**

## AN EDUCATIONAL TECHNOLOGY BIBLIOGRAPHY


Association for the Development of Computer-Based Instruction. *Mission of the Future: Proceedings of February 27-March 1, 1979 Convention*, San Diego, California, ERIC ED 175 447, 332 p., 1979.

Association for Educational Communications and Technology. *Learning Via Telecommunications: Readings from "Audiovisual Instruction,"* ERIC ED 164 006, 81 p., 1978.

"At Long, Long Last: The Videodisc," *EPIEgram: Equipment*, Vol. 7, pp. 3-4, January 15, 1979.

Bennion, Junius L. *Authoring Procedures for Interactive Videodisc Instructional Systems*, WICAT, Inc., Orem, Utah, March 1976.

Bennion, Junius L. and Schneider, Edward W. *Interactive Video Disc Systems for Education*, Division of Instructional Research, Development, and Evaluation, Brigham Young University, Provo, Utah, ERIC ED 158 719, 19 p., October 1975.

Bennion, Junius L. and Schneider, Edward W. "Interactive Videodisc Systems for Education," *Journal of the Society of Motion Picture and Television Engineering*, Vol. 84, No. 12, pp. 949-953, December 1975.

Bennion, Junius L. *Possible Applications of Optical Video Discs to Individualized Instruction Systems*, Division of Instructional Research, Development, and Evaluation, Brigham Young University, Provo, Utah (for NSF), ERIC ED 158 721, 10 p., February 1974.

Benson, K. Blair. "Videodisc Update," *Journal of the Society of Motion Picture and Television Engineering*, Vol. 86, No. 3, pp. 144-145, March 1977.

Bork, Alfred and Anderson, John. *The California Instructional Improvement Database*, University of California, Irvine, ERIC ED 163 978, September 1976.

Bork, Alfred. "The California Instructional Improvement Database," *California Journal of Teacher Education*, Vol. 4, No. 1, pp. 64-77, April 1977.

Bork, Alfred. "Computers and the Future of Learning," *Journal of College Science Teaching*, Vol. 7, No. 2, pp. 88-90, November 1977.

Bork, Alfred, et al. *Conference on Intelligent Videodisc Systems, Brief Informal Summary*, University of California, Irvine, ERIC ED 163 978, 14 p., December 1977.

Bork, Alfred. "Interactive Learning: Millikan Lecture, American Association of Physics Teachers," *American Journal of Physics*, Vol. 47, No. 1, pp. 5-10, January 1979.

Bork, Alfred. *Learning with Computers: Today and Tomorrow*, Physics Computer Development Project, University of California, Irvine, ERIC ED 102 959, 7 p., December 1974.

Bork, Alfred. "Machines for Computer-Assisted Learning," *Educational Technology*, Vol. 18, No. 4, pp. 17-20, April 1978.

Bork, Alfred and Anderson, John. "A Report on the California Instructional Improvement Database," *Technological Horizons in Education*, Vol. 6, No. 2, pp. 42-44, February 1979.

Bork, Alfred. "Stand Alone Computer Systems—Our Educational Future," *Journal of Educational Technology Systems*, Vol. 7, No. 3, pp. 201-207, 1979.

Bork, Alfred. "Videodiscs: The Ultimate Computer Input Device," *Creative Computing*, Vol. 2, No. 7, pp. 44-45, March/April 1976.

Boyle, Deirdre. "Media-Minded: Whatever Happened to Videodisc?" *American Libraries*, Vol. 8, No. 2, pp.97-98, February 1977.

Brandt, Richard C. and Knapp, Barbara H. *University of Utah Video Computer Authoring System, Version 1.6, User's Guide*, University Research Foundation,University of Utah, Salt Lake City, Utah, 1979.

Branson, Robert K. "Instructional Development," *Educational Communication and Technology: A Journal of Theory, Research, and Development*, Vol. 26, No. 2, pp. 123-132, Summer 1978.

Braun, Ludwig. *Microcomputers and Video Disc Systems: Magic Lamps for Educators?* State University of New York, Stony Brook, ERIC ED 154 839, 77 p., 1977.

Braun, Ludwig. "Video Discs: Magic Lamp for Educators?" *People's Computers*, Vol. 6, No. 4, pp. 14-15, January-February 1978.

Broussaud, G. "Le Videodisque—Generalies et Apercu Sur Ouelques Domaines D'Application," *Review of Technique Thomson-CSF*, Vol. 10, No. 4, pp. 655-680, December 1978.

Bunderson, Victor C.; Jarvis, Stanley; and Mendenhall, Robert F. *A Study of Authoring Alternatives for Training-Oriented Videodiscs*, WICAT, Inc., Orem, Utah (for the U.S. Navy Personnel Research and Development Center, San Diego, California), DIALOG File 6: NTIS 64-80/ISS03, 85 p., September 1979.

Burke, James. "Inventing the Future," *Connections*, Macmillan London Limited, pp. 287-294, 1978.

Buterbaugh, James G. "Motion, Aural, Visual Image Trends: Alias 'Film,'" *CUFC Leader*, Vol. 8, No. 2, Consortium of University Film Centers, University of Illinois Film Center, Champaign, pp. 8-10, Spring 1980.

Buterbaugh, James G. "New Educational Video Technology," *Sightlines*, Vol. 13, No. 3, Spring 1980.

Cavanaugh, Robert T. *Consumer Videoplayers*, North American Philips Corp., New York, April 1977.

Cavanaugh, Robert T. "Educational/Institutional Features of the Optical Videodisc," *Journal of the Society of Motion Picture and Television Engineering*, Vol. 86, No. 4, pp. 201-203, April 1977.

Christiansen, Donald. "Technology '80," *IEEE Spectrum*, Vol. 17, No. 1, pp. 30-31, January 1980.

Dann, Michael H. *The Videocassette and Video Disc in the Development of the Communications Media*, Children's Television Workshop, New York, New York, ERIC ED 084 790, 25 p., October 1973.

Daynes, Rodney R. *Videodisc Technology Use Through 1986: A DELPHI Study*, Navy Personnel Research and Development Center, San Diego, California, ERIC ED 145 823, 48 p., December 1976.

DeBloois, Michael. "Exploring New Design Models: Videodisc Capabilities." *Educational and Industrical Television*, Vol. 11, No. 5, pp. 34-36, May 1979.

Dignam, Monica. *Research on the Use of Television in Secondary Schools. Research Report 48*, Agency for the Instructional Television, Bloomington, Indiana, ERIC ED 156 166, 26 p., June 1977.

"Disc Wars: CBS Allies with RCA," *Time*, Vol. 115, No. 3, p. 65, January 21, 1980.

Dranov, Paula. *Publishing/Programming Opportunities in Consumer Video*, Knowledge Industry Publications, Inc., White Plains, NY, 1979.

Eastwood, Lester F., Jr. *Motivations and Deterrents to Education of "Intelligent Videodisc" Systems*, Center for Development Technology, Washington University, St. Louis, Missouri, ERIC ED 157 516, 57 p., January 1978.

Eastwood, L. F. "Motivations and Deterrents to Educational Use of Intelligent Videodisc Systems," *Journal of Educational Technology Systems*, Vol. 7, No. 4, pp. 303-335, 1979.

Evans, Art. "Videodisc on the Horizon," *Audiovisual Instruction*, Vol. 20, No. 5, pp. 31-33, May 1975.

Galbraith, G., et al. "Interfacing an Inexpensive Home Computer to the Videodisc: Educational Applications for the Hearing Impaired," *American Annals of the Deaf*, Vol. 124, pp. 536-541, September 1979.

Gray, Robert A. "Video Disc Technology: Its Potential for Libraries," *School Library Journal*, Vol. 24, No. 5, pp. 22-24, January 1978.

Gray, Robert A. "Watch Out for Videodiscs in Your Future," *Audiovisual Instruction*, Vol. 23, No. 9, p. 19, December 1978.

Hague, Syed M. S. "Video Applications in Education," *Educational Technology*, Vol. 18, No. 9, pp. 28-32, September 1978.

Heuston, Dustin H. *The Promise and Inevitability of the Videodisc in Education*, WICAT, Inc., Orem, Utah (for NIE), ERIC ED 153 636, 99 p., September 1977.

Hirschbuhl, John J. *Blueprint for the Future of Computer Based Instruction*, Akron University, Ohio, ERIC ED 154 835, 36 p., 1977.

Hirschbuhl, John J. and Seeman, Robert. *Future Review of CAI and the Coming of Videodisk Technology*, ERIC ED 144 526, 25 p., 1975.

Howkins, John. *Videotex: Words on the TV Screen. Viewdata, Teletext and the Rest*, Internal Institution of Communications, London, England, ERIC ED 175 064, 57 p., May 1979.

Humphrey, Darrell. "Computers in the Media Center of Tomorrow," *Audiovisual Instruction*, Vol. 22, No. 9, pp. 24-26, November 1977.

Ingalls, Richard E. *Intelligent Video Disc as a Major Component of Individualized Instruction*, ERIC ED 154 837, 11 p., 1977.

International Institution of Communications. *Videotex: Words on the Screen, Viewdata, Teletext and the Rest*, London, England, ERIC ED 175 064, 57 p., May 1979.

Jerome, Johnathan A. and Naczorowski, Edward M. "Film-Based Videodisc System," *Journal of the Society of Motion Picture and Television Engineering*, Vol. 83, No. 7, pp. 560-563, July 1974.

Kellock, A. "The Realm of Independent Study as a Market for the Optical Videodisc," Conference on Applications of Videodisc and Videodisc Technology, Carmel, California, July 19, 1977.

Kellock, A. *The Videodisc and Libraries*, McGraw-Hill Book Co., New York, June 1977.

Kenney, George C. "Special Purpose Applications of the Optical Videodisc System," *IEEE Transactions on Consumer and Electronics*, Vol. CE-22, No. 4, pp. 327-338, November 1976.

Kincheloe, Fontaine. "Sponsored Films and the Videodisc Revolution," *Educational and Industrial Television*, Vol. 8, No. 4, pp. 32-36, April 1976.

Levis, Art. "The Video Disc is Here: Spinning Fantasies into the Future," *Rolling Stone*, S. 2079, p. 67, September 20, 1979.

Lipson, Joseph. "Future Use of Technology in Science Education," *Instructional Technology*, Vol. 10, No. 1, p. 10, January 1980.

Love, J. "Videodisc: Television's New Horn of Plenty," *Media and Methods*, Vol. 16, pp. 16-18, October 1979.

Luehrmann, A. W. "Intelligent Videodisc Systems," *Computer and Communications: Implications for Education*, Academic Press, New York, pp. 367-469, 1977.

Lunin, Lois F. "Data Bases + Television + Telephone = Viewdata," *Bulletin of the American Society for Information Science*, Vol. 5, No. 1, pp. 22-23, October 1978.

"Magnavision in Altanta," *EPIEgram: Equipment*, Vol. 7, No. 4, January 29, 1979.

Mathieu, Michel. "Random Access System Adapted for the Optical Videodisc: Its Impact on Information Retrieval," *Journal of the Society of Motion Picture and Television Engineering*, Vol. 86, No. 2, pp. 80-83, February 1977.

Mokhoff, Nicolas. "Consumer Electronics," *IEEE Spectrum*, Vol. 17, No. 1, pp. 64-68, January 1980.

Molnar, Andrew R. "Intelligent Videodisc and the Learning Society," *Journal of Educational Technology Systems*, Vol. 8, No. 1, pp. 31-40, 1978-1980.

"Pandora's Tape: VTRs are Legal for Home Use," *Time*, Vol. 114, No. 16, p. 86, October 15, 1979.

Paulson, Bob. "The Technology Present and Applications Future of the Video Disc," *The Journal of the Society of Motion Picture and Television Engineering*, Vol. 89, No. 1, p. 28, January 1980.

Paulson, Bob. "What's Ahead for the Videodisc?" *Broadcast Engineering*, Vol. 20, No. 12, p. 56, December 1978.

Penn, Vivian S. "Television—Were the First 50 Years the Hardest?" *Catholic Library World*, Vol. 47, No. 5, pp. 212-215, December 1975.

"The Philips-Magnavox-MCA Magnavision/DiscoVision System," *Educational and Industrial Television*, Vol. 11, No. 1, pp. 35-78, January 1979.

Plott, John. *Learning and Teaching in the Electronic Society* National Institute of Education Task Force on Learning and Teaching, ERIC ED 167 120, 10 p., September 1977.

Priest, Alice. "RCA Chooses Financing Over Technology," *Business Week*, No. 2601, p. 88, September 3, 1979.

Propp, George, et al. "Satellite Demonstration: The Videodisc Technology," *American Annals of the Deaf*, Vol. 124 pp. 652-655, September 1979.

Rice, James, Jr. "There's a Videodisc in Your Future," *Library Journal*, Vol. 103, No. 2, pp. 143-144, January 15, 1978.

Robert, Walt. "Is It True What They Say About Videodiscs?" *Training*, Vol. 12, No. 12, pp. 80-82, December 1975.

Ruark, Henry C. "Videocassettes vs. Videodisc," *AV Guide: The Learning Media Magazine*, Vol. 5l, No. 6, pp. 12-13, June 1972.

Ruark, Henry C. "Video-Disc Developments, Impact on Production and Marketing," *Technical Photography*, Vol. 7, No. 8, pp. 16-33, September 1975.

Schneider, Edward W. *Applications of Videodisc Technology to Individualized Instruction*, Division of Instructional Research Development and Evaluation, Brigham Young University, Provo, Utah (for National Science Foundation), ERIC ED 158 722, 22 p., September 1975.

Schneider, Edward W. "Videodiscs, or the Individualization of Instructional Television," *Educational Technology*, Vol. 16, No. 5, pp. 53-58, May 1976.

Smellie, Don C. "Videodisc in the Classroom," *Educational and Industrial Television*, Vol. 11, No. 5, pp. 32-33, May 1979.

Smith, Ralph Lee. "A Telecommunications Primer for College Presidents—Part I: The Technologies Defined, EFL Educational Technology Profile 25," *Planning for Higher Education*, Vol. 7, No. 3, pp. 7-11, December 1978.

Smith, Ralph Lee. "A Telecommunications Primer for College Presidents—Part II: Implications and Issues, EFL Educational Technology Profile 26," *Planning for Higher Education*, Vol. 7, No. 3, pp. 16-23, December 1978.

Smith, Ralph Lee. "A Telecommunications Primer for College Presidents—Part III: Implications and Issues, EFL Educational Technology Profile 27," *Planning for Higher Education*, Vol. 7, No. 4, pp. 7-13, February 1979.

Smith, Ralph Lee. "A Telecommunications Primer for College Presidents—Part IV: The Communications Act Rewrite, EFL Educational Technology Profile 28," *Planning for Higher Education*, Vol. 7, No. 4, pp. 21-26, February 1979.

Smith, Ralph Lee. *The Wired Nation; Cable Television: The Electronic Highway*, First Edition, Harper and Row: New York, 1972.

Stein, Jan W. "Coming Soon—The Marriage of Television and Education," *Television Quarterly*, Vol. 16, No. 3, pp. 59-60, Fall 1979.

Subcommittee on Domestic and International Scientific Planning, Analysis, and Cooperation of the Committee on Science and Technology, *Computers and the Learning Society*, U.S. House of Representatives, Ninety-Fifth Congress, Second Session, U.S. Government Printing Office, Document Y 4.Sci 2:951JJ, June 1978.

Trojan, Judith. "Film and Video," *Media and Methods*, Vol. 13, No. 9, pp. 48-49, 60-61, May-June 1977.

Veil, H. "Taking Charge of Television: The Video-Cassette Recorder," *Futurist*, Vol. 13, No. 4, pp. 343-346, October 1979.

"Videodisc Activity Heats Up as CBS and Matsushita Announce Plans," *Videography*, Vol. 5, No. 2, p. 11, February 1980.

*The Video Register*, 80th Edition, Knowledge Industry Publications, Inc., White Plains, NY, 1979. (A directory of non-broadcast video users, manufacturers, producers, dealers, and services.)

*The Video Source Book* and *The Video Program: Index*, The National Video Clearinghouse, Inc., Syasset, NY, 1980.

*Video Users' Marketplace*, Knowledge Industry Publications, Inc., White Plains, New York. (A bi-weekly newspaper for users and producers of video hardware, programs, and services.

Vogel, Harold. *Video Market Commentary Update*, an Institutional Report of the Securities Research Division, Merrill Lynch Pierce Fenner and Smith, Inc., New York, 8 p., March 12, 1979.

VonFeldt, James R. *A Description of a Prototype System at NTID Which Merges Computer Assisted Instruction and Instructional Television*, National Technical Institute for the Deaf, Rochester, New York, ERIC ED 158 703, 11 p., January 1978.

Winslow, Ken. "A Videodisc in Your Future," *Educational and Industrial Television*, Vol. 7, No. 5, pp. 21-22, May 1975.

Winslow, Ken. "Videodiscs: Reality Begins (Almost)," *Educational and Industrial Television*, Vol. 6, No. 11, pp. 36-40, November 1974.

Winslow, Ken. "Videodisc Update: The MCA DiscVision PR-7820 Industrial/Educational Player," *The Videoplay Report*, Vol. 9, No. 15, pp. 1-6, July 23, 1979.

Winslow,Ken. "Videodisc Update: MCA DiscVision's Industrial/Educational Player Goes on Public Sale," *The Videoplay Report*, Vol. 9, No. 13, pp. 1-3, June 25, 1979.

Winslow, Ken. "Videodisc Update: Some Non-Consumer Experience," *The Videoplay Report*, Vol. 9, No. 12, pp. 1-5, June 11, 1979.

Winslow, Ken. "Videodisc Update: Technology and Techniques of Educational Applications," *The Videoplay Report*, Vol. 9, No. 16, pp. 1-7, August 6, 1979.

Winslow, Ken. "Videodisc Update: Victor/Matsushita Format Gains Momentum," *The Videoplay Report*, Vol. 10, No. 5, pp. 1-2, March 3, 1980.

Wood, R. Kent and Stephens, Kent G. "An Educator's Guide to Videodisc Technology," *People's Computers*, Vol. 6, No. 4, pp. 12-13, January-February 1978.

Wood, R. Kent and Stephens, Kent G. "An Educator's Guide to Videodisc Technology," *Phi Delta Kappan*, Vol. 58, No. 6, pp. 6,466-467, February 1977.

Wood, R. Kent. "A Reader's Guide to Videodisc Technology: A Selected Annotated Bibliography," *Learning Via Telecommunications—Readings from Audiovisual Instruction-3*. Association for Educational Communications and Technology, Washington, D.C., 1978.

Wood, R. Kent. "The Utah State University Videodisc Innovations Project," *Educational and Industrial Television*, Vol. 11, No. 5, pp. 31-32, May 1979.

Wood, R. Kent and Stephens, Kent G. "Videodiscs and Immediate Future Shock for Educators," *International Journal of Instructional Media*, pp. 229-233, 1976-1977.

Woolley, Robert D. "A Videodisc/Portable Computer System for Information Storage," *Educational and Industrial Television*, Vol. 11, No. 5, pp. 38-40, May 1979.

**For Additional Reading:**

## AN ENGINEERING TECHNOLOGY BIBLIOGRAPHY


Alder, Robert. "Video Disc System Alternatives," *IEEE Transactions on Consumer Electronics*, Vol. CE-22, No. 4, pp. 302-303, November 1976.

Anon, F. "RCA 'Selectavision' Videodisc System," *Information Display*, Vol. 12, No. 2, pp. 20-23, 1976.

Bartolini, R. A., et al. "In-contact Encapsulation of a Dye-Based Optical Video Disc," Conference on Laser and Electrooptical Systems (CLEOS), San Diego, California, February 1978.

Bartolini, R. A., et al. "Optical Disc Systems Emerge," *IEEE Spectrum*, Vol. 15, No. 8, pp. 20-28, August 1978.

Bell, A. E. and Spong, F. W. "Antireflection Structures for Optical Recording," *Journal of Quantum Electronics*, Vol. 14, p. 487, July 1978.

Bell, A. E., et al. "Fully Encapsulated Trilayer Optical Video Disc," Conference on Laser and Electrooptical Systems (CLEOS), San Diego, California, February 1978.

Bell, A. E., et al. "Optical and Thermal Aspects of the Design of Laser Recording Structures," Optical Society of America Annual Meeting, Toronto, Ontario, Canada, October 1977.

Berger, K. and Hamisch, J. J. "Laser Picture Storage System for Professional Applications," *Femseh Aktuell*, p. 10, February 1977.

Bernhard, Robert. "Solid State Looks to VLSI," *IEEE Spectrum*, Vol. 17, No. 1, pp. 44-49, January 1980.

Bogels, Peter W. "System Coding Parameters, Mechanics and Electromechanics of the Reflective Videodisc Player," *Journal of the Society of Motion Picture and Television Engineering*, Vol. 86, No. 2, pp. 74-79, February 1977.

Bouwhuis, G. and Braat, J. "Video Disk Player Optics," *Applied Optics*, Vol. 17, No. 13, pp. 1993-2000, July 1, 1978.

Braat, J. and Boiuwhuis, G. "Position Sensing in Video Disk Readout," *Applied Optics*, Vol. 17, No. 13, pp. 2013-2021, July 1, 1978.

Bricot, Claude. "Optical Readout of Videodisc," *IEEE Transactions on Consumer Electronics*, Vol. CE-22, No. 4, pp. 304-308, November 1976.

Broadbent, K. "A Review of the MCA DiscoVision System," *Journal of the Society of Motion Picture and Television Engineers*, Vol. 83, p. 554, July 1974.

Broussaud, G. "Le Videodisque—Generalies et Apercu Sur Ouelques Domaines D'Application," *Review of Technique Thomson-CSF*, Vol. 10, No. 4, pp. 655-680, December 1978.

Bulthuis, Kees. "Optical Video Disc Systems," *Proceedings Laser 77 Opto Electronics*, Munich, Germany, June 1977.

Bulthuis, Kees and Kenney, George C. "Philips MCA Videodisc Systems," *Journal of Optical Society of America*, Vol. 66, No. 4, p. 379, April 1976.

Bulthuis, Kees, et al. "Ten Billion Bits ona Disc," *IEEE Spectrum*, Vol. 16, No. 8, pp. 26-33, August 1979.

Carasso, M. and Kleuters, W. "Diode Laser Recorder with Pregrooved Disc," Symposium on Optical Data, Display Processing and Storage, Orlando, Florida, January 1979.

Cavanaugh, Robert T. *Educational/Instructional Features of the Optical Videodisc System*, North American Philips Corp., New York, April 1977.

Clemens, J. K. "Capacitive Pickup and the Buried Subcarrier Encoding System for the RCA Videodisc," *RCA Review*, Vol. 39, No. 1, pp. 33-59, March 1978.

Compaan, K. and Kramer, P. "The Philips VLP System," *Philips Technical Review*, Vol. 33, No. 7, pp. 178-180, 1973.

Firester, Arthur H., et al. "Optical Readout of the RCA Videodisc," *RCA Review*, Vol. 39, No. 3, pp. 392-426, September 1978.

Firester, Arthur H. et al. "Optical Recording Technique for the RCA Videodisc," *RCA Review*, Vol. 39, No. 3, pp. 427-471, September 1978.

Fox, L. P. "Conductive Videodisc," *RCA Review*, Vol. 39, No. 1, pp. 116-135, March 1978.

Gordon, W. J. "Videodisc Testing Philosophy and Techniques," *RCA Review*, Vol. 39, No. 1, pp. 186-197, March 1978.

Gorog, I. "Optical Techniques Developed for the RCA Videodisc," *RCA Review*, Vol. 39, No. 1, pp. 162-185, March 1978.

Haas, Mark. "Consumer Electronics in the Eighties—A Report on the EIA Consumer Electronics Show," *Technical Education News*, Vol. 38, No. 12, pp. 1-2, December 1979.

Heemskerk, J. P. "Noise in a Video Disk System: Experiments with an AIG as Laser," *Applied Optics*, Vol. 17, No. 13, pp. 2007-2012, July 1, 1978.

Jacobs, B. A. "Laser Beam Recording of Video Master Disks," *Applied Optics*, Vol. 17, No. 13, pp. 2001-2006, July 1, 1978.

John, D. W. and Volk, A. "Microcomputer Sets Packs It All In to Three Chips," *Electronics*, pp. 109-113, May 12, 1977.

Keizer, E. O. and McCoy, D. S. "Evolution of the RCA Videodisc System Perspective," *RCA Review*, Vol. 39, No. 1, pp. 14-32, March 1978.

Keizer, E. O. "Videodisc Mastering," *RCA Review*, Vol. 39, No. 1, pp. 60-86, March 1978.

Kenney, George C. et al. "Experimental Optical Disc Data Recorder," Conference on Laser and Electrooptical Systems (CLEOS), San Diego, California, February 1978.

Kenney, George C. et al. "An Optical Disc Replaces 25 Mag Tapes," *IEEE Spectrum*, Vol. 16, No. 2, pp. 33-38, February 1979.

LeCarvennec, F. "Professional Applications of Optical Video Disc Technology," Conference on Laser and Electrooptical Systems (CLEOS), San Diego, California, February 1978.

Lurie, M. and Flory, R. E. "Developing a Broadcast Quality Optical Video Disc System," Conference on Laser and Electrooptical Systems (CLEOS), San Diego, California, February 1978.

Mayden, D. "Micromatching and Image Recording on Thin Film by Laser Beams," *Bell System Technology Journal*, Vol. 50, pp. 1761-1789, 1971.

*Mission of the Future, Proceedings of the Annual Convention of the Association for the Development of Computer-Based Instructional Systems. Volume I*, San Diego, California, ERIC ED 175 447, 332 p., March 1979.

Mokhoff, Nicolas. "Communications and Microwave," *IEEE Spectrum*, Vol. 17, No. 1, pp. 38-43, January 1980.

Naruse, Y. and Ohkoski, A. "A New Optical Video Disc System with One Hour Playing Time," The Institute of Electrical and Electronics Engineers, Inc. (IEEE), Chicago Spring Conference on Consumer Electronics, June 1978.

Naruse, Yohsuke and Ohkoshi, Akio. "New Optical Videodisc System with One Hou. Playing Time," *IEEE Transactions on Consumer Electronics*, Vol. CE-24, No. 3, pp. 453-455, August 1978.

Noyce, Robert N. "Large-Scale Integration: What is Yet to Come?" *Science*, Vol. 195, No. 4283, pp. 1102-1106, March 18, 1977.

Palermo, P. et al. "Video Disc Mastering and Replication," *Optics and Laser Technology*, p. 169, August 1977.

Panigrahi, G. "The Implications of Electronic Serial Memories," *Computer*, Vol. 10, No. 7, pp. 18-25, July 1977.

Pepper, R. and Sander, I. "High Density Direct Read and Write (DRAW) Recording," *Optica Acta*, Vol. 24, p. 427, 1977.

Petritz, Richard L. "The Pervasive Microprocessor: Trends and Prospects," *IEEE Spectrum*, Vol. 14, No. 7, pp. 18-14, July 1977.

Rhodes, R. N. "Videodisc Player," *RCA Review*, Vol. 39, No. 1, pp. 198-221, March 1978.

Roach, W., et al. "Diffraction Spectrometry for Videodisc Quality Control," *RCA Review*, Vol. 39, No. 3, pp. 472-511, September 1978.

Ross, D. L. "Coatings for Videodiscs," *RCA Review*, Vol. 39, No. 1, pp. 136-161, March 1978.

Ryan, R. J. "Material and Process Development for Videodisc Replication," *RCA Review*, Vol. 39, No. 1, pp. 87-115, March 1978.

Sheng, Ping. "Theoretical Considerations of Optical Diffraction from RCA Videodisc Signals," *RCA Review*, Vol. 39, No. 3, pp. 512-555, September 1978.

Spitz, E. "Optical Video Discs," Conference on Laser Engineering and Applications (CLEA), Washington, D.C., May 1975.

Steckler, L. "Videodisc—A Look at the Circuitry," *Radio-Electronics*, Vol. 50, No. 6, pp. 50-53, June 1979.

Tsunada, Y. et al. "Semiconductor Laser Pickup for Optical Video Disc Player," *IEEE Transactions on Consumer Electronics*, Vol. CE-23, No. 4, pp. 479-493, November 1977.

Velzel, C. H. "Laser Beam Reading of Video Records," *Applied Optics*, Vol. 17, No. 13, pp. 2029, 2036, July 1, 1978.

Winslow, John. "Mastering and Replication of Optical Videodiscs," *Journal of Optical Society of America*, Vol. 66, No. 4, p. 379, April 1976.

Zwaneveld, Eddy H. A. E. "Videodisc Technology," IEEE 1975 Region 6 Conference, Salt Lake City, Utah, May 7-9, 1975.